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FISH BAITS: THEIR COLLECTION, CARE, PREPARATION AND PROPAGATION

Compiled in the Division of Game-fish and Hatcheries

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INTRODUCTION

Baits may be classified as artificial and natural. Artificial baits consist of flies, spoons, spinners, plugs, and a multitude of other contrivances made from a large number of materials. Natural baits, with which we are concerned primarily, include worms, crayfish, insects, minnows, frogs, and many other animal forms.

Most States have laws governing the collection and propagation of baits. Your State fish and game commission will furnish you information regarding local regulations, if requested.

COLLECTION AND PROPAGATION

CRAYFISH

These crustaceans may be collected from the riffles of streams and from shallow-water areas of pools, ponds, and lakes. They are often found under stones, boards, and other objects.

In ponds and streams where crayfish are abundant they may be trapped as follows: A wooden framework of any convenient size (18 by 30 by 18 inches, for example) should be covered with 1/4-inch mesh galvanized screen wire and have fitted into one end a removable funnel of the same material. This funnel should have a flattened opening (about 4 inches wide and 1½ inches deep) and should project some 6 to 10 inches into the box. The trap should be set in shallow water, the entrance toward a sloping bank and the bottom embedded in the mud, sand, or gravel where crayfishes are found. Preliminary exploration under stones and along the shore where holes are dug will usually help in locating the set. Fresh meat or other juicy animal remains should be used as bait. If the bait is placed in a can with holes in each end to permit the juices to exude, it will not be eaten and consequently will be available to attract crayfish over a longer period. Overnight sets are much more remunerative than daytime efforts.

Crayfish can be kept alive in tanks, small pools, or wooden boxes which are well supplied with running water. The containers should not be overcrowded, and they should be cleaned often. The best food for crayfish is fresh meat in small pieces, but care should be taken to leave no old or spoiled meat in the water for more than a few hours, as this will soon prove fatal. All dead crayfish should be removed immediately.

A soft crayfish is one that has cast off its old shell and has a new shell forming. No satisfactory system has been devised for keeping the crayfish shell soft. A constant supply can be made available by maintaining quantities of crayfish in ponds, feeding them to promote growth, and then selecting the soft ones as desired. Soft individuals can be kept 1 or 2 days by placing in a refrigerator or cold water.

The shallow-burrowing forms may be propagated in ponds. At some fish-cultural stations they have been propagated in conjunction with game-fish. Information on raising may be obtained from Bait Culturists' Guide, Bulletin 137 of the Ohio Division of Conservation and Natural Resources, Columbus, Ohio.

Only the shallow-burrowing forms such as Cambarus rusticus or the smaller species Cambarus immunis should be propagated, for the deep-burrowing forms will dig into dikes and cause leakage, resulting sometimes in severe damage. The dike damage can often be prevented by killing the crayfish with chemicals. One method is to place 10 drops of carbon disulfide in the burrow and close the entrance. One gallon of carbon disulfide will treat approximately 5,000 holes. Carbon disulfide is inflammable and explosive. The user should not smoke nor bring it near an open flame. Another method of control is the use of commercial cattle dip. Mix 1 part dip to 150 parts of water. One to 2 ounces applied to each hole is adequate. To avoid missing holes, it is well to close all holes as they are treated.

Crayfish mate in the fall. Soon after mating the females burrow into the banks of the pond at about water level. For this reason the draining of ponds in late August or early September may provide effective control, particularly where heavy infestation occurs. A combination of draining and chemical treatment wherever possible would be preferable.

FIDDLER CRABS

These crabs may be collected in marshy areas along the coasts at low tides. Placed between layers of moist grass in a cardboard or wooden box, they may be carried several hours or even 1 or 2 days. Care must be taken to place the crabs right side up and not on top of each other between the layers of grass. The crabs must be kept cool, as heat will destroy them in a short time.

EARTHWORMS

These worms are also called angleworms, night-crawlers, gardenworms, rainworms, fishworms, and groundworms. There are two principal kinds: The earthworm, which is a solid pinkish-red; and the dungworm, which has marked red rings and exudes an unpleasant yellow secretion when handled or cut.

The dungworm is found in manure piles and in heavily manured soil. It has the advantage of being more readily obtained in winter. The earthworm becomes larger than the dungworm.

Earthworms may be collected during the humid season by exploring with a lantern or flashlight the surface of almost any well-fertilized or rich sod after dark. Better results are obtained after a rain and in areas where there are a few large trees. The best light for the purpose is one fitted with a red glass or lens, as red light does not frighten the worms.

Another method that has been used is to tap or hammer on the surface of the area where worms are known to be present. Still another method is to drive a stake into the ground to a depth of 10 or more inches and vibrate it by rapidly rubbing a board or the head of an axe over the top of the stake. Electrodes with coils, such as used in Model-T Fords, and batteries have also been used successfully. A solution made by dissolving one bichloride of mercury tablet to a gallon of water and placed in worm holes, has been reported as a successful method of collecting night-crawlers during the day. About 2 ounces or less of the solution to a hole, is adequate. Digging is a method commonly used to obtain worms during all periods of the year, but by no means is it always the easiest. The humus heap which most gardeners accumulate should not be overlooked.

One of the essentials in storing and raising earthworms is to keep them in a temperature below 60°F. Temperatures above 70° or 75°F., are fatal. Worms should be kept in a rustproof container, preferably one made of wood or earthenware. A tight wooden box 18 by 36 by 18 inches will serve as a rearing-box for several hundred worms. The box should be well tarred on the outside and lined with hot paraffin wax. The lid should fit well and serve as a roof to keep out rain. The box may then be filled with rich, damp soil and stocked with worms. The worms should be fed occasionally with chopped beef suet, bread crumbs, corn meal, or other fat or starchy foods.

Where compost heaps are maintained, these may be stocked with worms if they are not already present. The rich, moist soil around the base will provide worms throughout the year.

Earthworms will live longer on the hook and will take more fish if well "scoured." This toughening process is accomplished by placing the worms in earthenware or wooden boxes containing damp moss for 1 to 4 days before they are to be used.

CLAM WORMS AND SANDWORMS

These annelid worms are sold on the North Atlantic Coast as bait for salt and brackish-water fish. Collectors in Maine have an industry worth a quarter million dollars a year from these worms. The industry in that State is centered around Wiscasset, but the industry extends from Long Island, New York, northward. The larger collections usually are taken in April but may continue into August. The worms average 6 to 8 inches in length. They spawn in the spring, at which time the ripe worms are unfit for bait. The spawners are easily identified. When spawners are held up, the insides flow to one end. The fluid from a broken spawner, if mixed with other worms, will kill them.

The clam worms, sometimes called blood worms, are represented by several species along the Atlantic Coast. The most common, Nereis virens, is flesh-colored and has a greenish sheen and black jaws. It is found from Long Island to Labrador.

The sandworms most commonly collected are Glycera Americana and Glycera dibranahiata, which occur from the Carolinas to the Bay of Fundy. The Glycera, which have a cylindrical body, elongated snout, four small tentacles, and four teeth, are differentiated from Nereis, which have a slightly flattened body, short snout, two small tentacles, and two teeth.

As the Glycera may destroy the Nereis if the species are placed together, they should be stored separately.

Both species are found under stones and among seaweeds, particularly in burrows, but at night they extend their bodies in search of food or leave the burrows entirely. The openings of the burrows are usually covered with sand, but open entrances may be found, and these make excellent places to dig for worms. The sandworms are usually deeper in the mud than the clam worms. The worms may be stalked with a light on the tidal flats during the dark moonless nights. At the slightest vibration from footsteps or a quick movement of the hand, the worms disappear. Worms are packed in rockweed and may be kept for several days in a refrigerator.

The worms refuse to eat in captivity and consequently have not been propagated.

CRICKETS AND ROACHES

Crickets and roaches are fine baits for sunfishes during the summer and fall. Usually abundant during these months, these insects may be found under piles of decaying plants, boards, and other objects in fields, fence rows, and similar areas. They are hard to collect, however, in large numbers. Fortunately, crickets and roaches can be raised with a minimum amount of care.

Crickets

As demonstrated at Alabama Polytechnic Institute, crickets may be raised in garbage cans, lard cans, metal drums with the tops removed, metal-lined boxes, or similar containers. The container should be placed in a dry basement, garage, or other building that is screened; otherwise, the container must be covered with fine-mesh screen, such as is used in screen doors, to

protect the crickets from ants, spiders, and parasites. The inside of the container should be sandpapered and coated with wax or varnish some 8 to 10 inches from the top to prevent the crickets from escaping. Four to six inches of clean, fine, damp sand should be placed in the bottom of the can: if the sand feels damp to the hands, it will furnish enough moisture for hatching the first crop of crickets. Excelsior, straw, or other material should be placed over the surface of the sand to provide protection for the young.

To stock a can 2 feet in diameter, 20 to 30 adult crickets should be used; larger containers will accommodate proportionately more adults. The can should be examined every 3 or 4 days during the first 2 weeks. Dead crickets should be removed. Occasionally there may be diseased crickets in the original stock.

Poultry laying mash has been found satisfactory as a food, but a great variety of feeds can be used. Those foods that do not mold too quickly are satisfactory. About 2 pounds of laying mash are required for each 100 crickets produced.

An ordinary baby-chick waterer or a 1-quart fruit jar inverted in a saucer-like glass dish is satisfactory to furnish drinking water. The saucer should be filled with cotton slightly above the water level to prevent to small crickets from drowning.

The floor around the cans should be dusted with derris powders or other insecticides every 1 or 2 months to keep out ants, which kill crickets.

The cans should be heated with a light bulb. For best results the heat should be maintained between 70° and 90°F., preferably near 80°F. At a temperature of about 80°F., the eggs hatch within 15 to 25 days and the young crickets become large enough for bait in about 1 month. They require about 3 months to reach maturity.

About 400 crickets have been raised every 3 months in a can 24 inches in diameter. A can 15 inches in diameter produces about half that number.

Roaches

Cockroaches, the familiar household pest, may be raised in containers similar to those described for crickets. For cockroaches, however, the container must be kept covered at all times. A piece of cheesecloth stretched over the top and held in place by a rubber band, makes a satisfactory cover. A rim of vaseline around the sides near the top of the box or jar will help to prevent their escape when the container is uncovered. Another precaution to prevent their escape and subsequent infestation of the building in which they are kept, is to keep the container surrounded with an insect powder containing rotenone.

Roaches feed on a great variety of foods but have shown preference for a mixture of bread, cornstarch, and water, with green food such as lettuce added. Sour milk and library paste make a good food. A stock diet found

satisfactory is whole ground wheat (50 per cent), dried skim milk (45 per cent), and dried baker's yeast (5 per cent). Roaches consume large amounts of water, which can be supplied in the same way as described for crickets.

The removal of cockroaches from the container may best be effected through a hole in the bottom with a metal shaft leading downward. They may be swept down the shaft into another container edged at the top with vaseline to prevent easy escape before the lid is applied.

A good place to obtain breeding stock is under the bark of rotten logs and around lamp posts at night. Debris and garbage containers and the dark places of commercial eating establishments are excellent habitats for cockroaches.

MEALWORMS

Mealworms are larval forms of the beetle family, Tenebrionidae, pests in flour, meal, and grains. They are included here because they are easy to raise and are used extensively for feeding the larger aquarium and bait fishes, salamanders, tree frogs, and other forms, and in the capture of bait minnows.

For raising these larvae, galvanized-iron or tight wooden boxes are used. It is important that the inside walls be made smooth with a thin coat of varnish to prevent the escape of the worms. The boxes may be of any convenient size: the size ordinarily used is about 1½ by 1 by 1 foot. Mealworms are about an inch long. A fine mesh wire or cheesecloth cover is necessary to prevent the escape of the adults.

Chicken growing mash or other types of grain meals may be spread over the bottom of the box to a depth of 1/4 inch and covered with four or five layers of burlap, a sprinkling of mash under each layer of cloth. The powdered meal from an old box will usually contain many eggs. If this powder is used in the bottom layer of the box and fresh mash and burlap are added, a rich culture may develop. Moisture may be provided by the addition of succulent foods such as pieces of raw potato or ripe apples, or by a damp cloth placed on the surface and slightly dampened every few days. Too much moisture will cause the development of mold, which should be avoided.

The box may be stocked with several hundred worms. Within 90 days the box should be abundantly populated with larvae. When adult beetles appear, the colony can be expanded by placing the adults in new culture boxes.

Mealworms can frequently be purchased from pet shops, aquarium dealers, and biological supply houses. Old grain that has been stored for sometime in feed stores, grain elevators, and farm feed bins may be another source of supply.

FROGS

Frogs--adult frogs and immature frogs after they have developed legs--make excellent bait for bass, pickerel, walleyes, and other fishes. Usually frogs are captured at the water's edge along stream banks and lake shores or in swampy places. A favorite method is to hunt them at night with a bright light. Dazed by the light, the frogs are caught by hand or with a dip net and then placed in a cloth bag.

During midsummer and early fall frogs may frequently be collected in meadows. Frog hunters often take advantage of the migration from the field to the swamps in the fall and devise various types of traps for the capture of these amphibians. Frogs hibernate during the winter and cannot then be caught. The capture of frogs in large numbers during early spring and spawning season is a destructive practice and should be discontinued.

Frogs must be kept in a damp place, out of the direct rays of the sun. If they are placed in live boxes or sacks in a pond or stream, it is essential that the frogs be permitted to reach the surface to breathe.

The propagation of frogs on a commercial scale has not been successful except where a large acreage of suitable area exists.

SALAMANDERS

Salamanders, sometimes called mud-puppies or spring lizards, make excellent bass bait and are tops with trout fishermen who use baits. Fishermen frequently collect salamanders from riffles or "fast" water by turning over stones and permitting them to wash into a fine mesh net placed below. They are usually collected along with hellgramites. Salamanders may also be collected in springs and under logs and flat rocks along a stream bank or lake shore. This excellent bait can be kept several days if placed in wet moss and covered with wet burlap, kept damp and in a cool place.

HELLGRAMITES AND OTHER AQUATIC FORMS

Hellgramites are the larvae of a large-winged insect known as the Dobson fly. Hellgramites are found under stones in swift riffles. They are taken for bait by turning over stones and permitting the water to carry them into a fine mesh net placed a short distance downstream. This bait may be carried in damp moss.

Other nymphs such as stoneflies, mayflies, dragonflies, the larvae of certain Diptera and salamanders, as well as other forms of life, may be taken by the same method.

COLLECTION AND PROPAGATION OF MINNOWS

In the past decade the annual catch of game-fish has increased tremendously, and with the increased catch there has been an increased demand for bait minnows. Hundreds of bait-minnow dealers procure their stock from public waters. This drain on the natural food of bass and predacious game-fish has reduced and endangered the sport-fishing in some waters. As a result, many States have passed legislation regulating the taking of minnows and other bait forms.

Much of the damage to the natural food supply could have been averted by proper sorting and handling. All too often more minnows have been killed or have died because of improper handling than have survived to be used as bait.

Dealers often suffer losses while holding minnows for sale in tanks. Excess chlorine in city water may cause losses. These losses can usually be avoided by using a reserve water tank exposed to air, where the chlorine is dissipated within 1 to 3 days, depending on the amount present. If the water is brought into the tank in a thin sheet flowing over a rough bottom to effect the maximum amount of aeration, much of the chlorine will be released. Commercial apparatus for the removal of chlorine is available from manufacturers of chemical equipment. Holding tanks should be shallow and have extensive surface area; water should be brought in at or above the desired water level, and overflows that take the water from the bottom are preferable. Where it is impossible to provide a sufficient quantity of running or circulating water for a tank of fishes, a fine jet of compressed air will serve to aerate the water. A floating live box made with a wooden frame and covered with a wire screen having 4 meshes per inch may be employed in a stream or lake if running water is not available.

Most losses of bait minnows are due to overcrowding; sudden changes in temperature; rough handling; holding in new galvanized iron, unseasoned concrete, or freshly creosoted containers; feeding more food than the fish will consume in 10 minutes; and allowing unconsumed food and dead fish to remain in the tanks. Heavy losses from fungus often occur during the hot days of July and August. When such abnormal losses occur, the fish should be dipped for 30 seconds in a solution of zinc-free Malachite green produced by adding 1 grain by weight to a quart of water (1 ounce equals 437 grains), equivalent to a concentration of 1 to 15,000 by weight. Infections can frequently be avoided by disinfection of containers and dip-nets in a solution of permanganate of potash made by dissolving 1 grain in 2 gallons of water.

During the last decade bait dealers have become increasingly interested in propagating minnows. The propagation of bait in small artificial ponds, if properly managed, will provide a supply of bait that will justify the cost of pond construction and maintenance. Dealers who propagate their own bait reserve the natural food supply for game-fish, provide better bait for the anglers, and save the transportation of minnows from distant waters.

A good bait minnow must be active and hardy on the hook and able to stand adverse conditions in the bait pail and holding tank. The fishes most economical to propagate are those that have a high reproductive capacity, spawn on aquatic plants and submerged objects in quiet waters, and feed on microscopic plants and animals or organic substances of the bottom sediments. The bait minnow should be a fast grower, reaching marketable size in a few summer months. Most important, it should be readily taken by game-fish, and it should not be harmful to other fishes if it escapes and becomes abundant in new waters.

For practical purposes minnows may be divided into two groups according to their spawning habits. The pond spawners comprise those species which reproduce freely in small ponds under natural conditions. The stream spawners include the species that spawn in running waters. Some of the stream spawners permit their eggs to be taken artificially, after which the eggs may be hatched in jars or on trays and the fry released into ponds to complete their growth. These species will not spawn in ponds except to a limited degree.

In selecting species for propagation, one must consider also the facilities at hand and the species and sizes most in demand at various seasons of the year. A species inhabiting local waters is usually preferred.

Pond-Spawning Minnows

Pond-spawning minnows that are popular for growing for bait purposes include: blunt-nosed minnow (Hyborhynus notatus), black-headed or fat-headed minnow (Pimephalas promelas), and the golden shiner (Notemigonus crysoleucus).

In rearing pond-spawners, ponds of almost any size from 1/10 acre to 20 acres may be used. Small ponds of 1/8 to 1/4 acre are preferred because they are easily drained and quickly filled; or, if drainage is not possible, they can be seined easily after obstructions have been removed. Large quantities of water flowing through the pond are not necessary; in fact, better results will be obtained with only sufficient water to maintain the surface level without marked fluctuations. If only one or two ponds are available, it will probably be better to raise only one species of minnow. Because it is difficult for the layman to identify the various species of minnows, it is advisable to obtain brood stock from a reputable breeder.

A list of minnow dealers may be obtained from the Fish and Wildlife Service, Department of the Interior, Merchandise Mart, Chicago 54, Illinois.

The Blunt-nosed Minnow

These minnows occur naturally in almost every pond, lake, and stream throughout their natural range, which includes the Mississippi River drainage, the Gulf Coast States, the Great Lakes basin, and North Atlantic coastal streams as far south as Virginia. The mature males reach a length of about 4 inches; the females, 3 inches. They spawn under logs, stones, and other objects at a depth of about 18 inches although they have been observed to spawn in water 2 inches to 8 feet deep. Their propagation is aided by installing in the pond boards, sticks, and other objects under which the eggs may be attached. Where vegetation is abundant, these aids are not essential for successful propagation. The females do not spawn until their second summer. In the northern States the spawning season extends from May to late August. They will begin spawning when the water reaches about 70°F., and the eggs hatch in 7 to 14 days depending on water temperature. They have been propagated in ponds at the rate of more than 100,000 per acre. Their food consists of microscopic plants, crustacea, and small aquatic insects.

Black-headed or Fat-headed Minnow

These minnows have a wide distribution in the United States east of the Rockies but have not been reported from the southeastern States. They are most commonly found in small ponds and sluggish streams. Spawning habits are very similar to those of the blunt-nose minnow. The young grow rapidly, reaching about 2½ inches in 2 months. The maximum length is about 3 to 4 inches. Many of the early hatched fish apparently reach sexual maturity and spawn be-

fore the end of the first summer. Large numbers of the black-headed minnows die after spawning. This point should be considered and arrangements made to market the adults at the proper time. This species has been propagated at the rate of more than 200,000 per acre. Their food is similar to that of the blunt-nose.

Golden Shiner

This minnow has a natural range over the entire United States east of the Rockies. It has a compressed and deep body. In the colder water of the northern States the golden shiner may reach only 3 inches during its second and 5 to 10 inches in four or five summers, whereas in the southern States it may reach 4 or 5 inches during its first summer and 18 inches in four or five summers. It matures sexually at a length of 2-3/10 to 3-5/10 inches or at an age of 1 or 2 years in the northern States. In the North Central States it has been grown to a length of 4 inches in one summer. It begins spawning in May in those States and continues into August. Successful propagation depends upon the presence of aquatic vegetation in liberal amounts, as the golden shiner spawns over vegetation to which the eggs adhere. This species has been propagated at rates of more than 100,000 per acre. The principal food consists of microscopic crustacea, algae, and small aquatic insects.

Other Pond-Spawning Minnows

Other pond-spawning minnows that have been propagated are the red-fin (Notropis whipplii), red-bellied dace (Chrosomus erythrogaster), round shiner (Hybognathus nuchalis), and blue-headed red-fin (Notropis cyanocepaalus).

Stream-Spawning Species

Some of the stream-spawning fishes that have been propagated are the horned dace (Semotilus atromaculatus), horny-headed chub (Nocomis luguttatus), stone-roller (Campostoma anomalum), common sucker (Catostomus commersonii), and the chub sucker (Erimyzon sucetta). These species spawn on gravel beds in riffles or on lake beaches where the wind action causes a strong current. For propagation, the eggs may be taken and fertilized artificially and then transferred to hatchery jars or trays for hatching. The fry are removed to ponds for rearing. The common sucker and chub sucker become large enough so that they are easy to handle when the eggs are taken, which makes the process far easier than with the minnows. Their eggs are capable of a high degree of fertilization under artificial means, and their growth in fertilized ponds is rapid. The propagation of the stream-spawning fishes is inadvisable unless one has had some experience in handling these species and has the hatchery equipment.

Stripping and Fertilizing Stream Spawners

Stripping or taking the eggs of minnows is a delicate task for the beginner, but after some experience the breeders can be handled without serious injury. Those males and females ready for spawning should be separated. Unripe fish should be returned to the water, as they will not provide fertile eggs and serious injury may result if stripping is attempted. The ripe individuals should give their eggs and milt freely under light pressure with the thumb and forefinger moving downward over the abdomen toward the vent. The female is stripped into a dampened pan and immediately afterward the milt from a male is expressed over the eggs. The eggs and milt are stirred gently with the fingers. Four or five pair are stripped into the pan, and the eggs and milt are stirred frequently. After 2 or 3 minutes water may be slowly added to the pan and the stirring gently continued either with the fingers or by slowly rotating the pan. After 10 or 15 minutes the milt may be washed from the egg mass by frequent changes of water. The eggs may then be transferred directly to the hatchery jars or trays.

Sucker eggs must be allowed several hours to harden after being fertilized and washed; otherwise the eggs, placed in jars too soon, have a tendency to adhere en masse. If this happens, it will be necessary to place the eggs on a screen of proper mesh under water and work the eggs through, after which they may be returned to the hatchery jar or tray.

Sudden jars or shocks must be avoided. When the eggs are to be transported a considerable distance by truck, they should be allowed to stand several hours and then carried in deep pails. Eggs are transported with less shock if there is no splashing of the water. This may be accomplished by the use of containers--with tight lids--half filled with eggs and then completely filled with water.

Hatching Stream-Spawners

These eggs must have clear running water at all times. They may be hatched in jars or on egg trays in troughs.

The troughs may be constructed of wood or galvanized sheet metal. A convenient trough for minnows is 10 feet long, 10½ inches wide, and 6 inches deep. This should be provided with a regulated water supply at the upper end and a fine mesh screen and overflow pipe at the lower end. The eggs are hatched on 10- by 24-inch trays made of 3/4- by 7/8-inch wood. The bottom may be covered with a good grade of cheesecloth or fine bobbinet. Screening similar to that used in screen-doors may be used if it is coated with asphaltum varnish several times to reduce the size of the meshes to prevent loss of the eggs. Copper-coated screening should be avoided, as copper in contact with eggs will poison them. If porous cloth is used, it should be tacked on tightly

After the trays have been soaked in water, the eggs may be placed in them and thinly spread by shifting the trays back and forth under the water surface. (Better results may be expected if the eggs do not cover the entire screen.) The trays can then be wedged by two wooden wedges crossing each other at right angles between the edge of the tray and the side of the trough. The upstream edge of the tray should rest on or near the bottom of the trough, and the downstream end should be stabilized at the surface of the water. The water should be regulated to a continuous, gentle current with a depth of 5 inches at the lower end. About five trays of eggs may be hatched in a trough. Risk of loss of eggs through accidents may be reduced by hatching in more than one or two trays. As soon as the eggs have hatched, the fry should be moved to the bottom of the trough and the trays removed. When the yolk-sacs have been absorbed and the fry swim up off the bottom, they may be removed with a flat dip net to pails and transferred to rearing ponds.

Hatchery jars may be used instead of trays and will usually save considerable labor once the equipment and technic are obtained. In walleyed-pike hatcheries the Meehan or similar hatching jar, containing about 3 gallons of water, is used. Eggs usually occupy about one-third to one-half the height of the jar, which may contain about 200,000 minnow eggs. The water enters at the bottom of the jar and is regulated by a petcock providing just the right amount of water to keep the eggs in slow motion. Rapid boiling will damage the eggs. The water overflows through a groove or lip at the top into a small flume that collects the water from other hatchery jars and carries it into a trough or tank at about the same level. If the eggs clump together, they should be stirred with a long feather. Ordinarily the bad eggs will be carried out with the overflow; if they are not carried out automatically, they should be removed with a rubber suction bulb and glass tube. When the eggs are hatched, the egg shells and fry will be carried with the overflow water through the flume to the tank or trough. Great care must be exercised at this time to see that the egg shells do not stop the screen in the holding tank and cause the water to overflow. A long screen placed at an angle at the lower end of the tank will give more surface area on which the egg shells may collect, reducing the cleaning time and risk of loss. As soon as the fry have absorbed their yolk-sacs, they may be removed to the rearing pond.

The hatching-jar technic has many variations which can be utilized to reduce expenses. Minnows have been hatched in milk bottles, and there is no reason why other similar types of containers cannot be used. Each container must be provided with a regulated water supply, and it must be possible for the young fry to escape from the hatchery jar to the holding tank without injury. Water may be supplied to the jars with rubber, glass, or plastic tubing

and regulated with screw clamps at rubber joints if glass or plastic tubing is used. The supply tube should reach the bottom of the hatchery jar, and the discharge should be from the surface. It is better to have the eggs in several jars rather than in one or two, as there is less likelihood of loss of all the eggs if part of the equipment ceases to function properly. The hatchery jars may also be operated in fine mesh wire baskets for collecting the newly hatched fry. After hatching of the eggs, the baskets--with the hatchery jars removed--may be lifted out and placed in containers for transporting to the rearing ponds.

Anyone expecting to strip, fertilize, and hatch minnow eggs will be well repaid by a visit to a State, Federal, or private hatchery to obtain first-hand information. Stations that hatch walleyed pike eggs will have hatching jars, and stations propagating trout will have the trough and tray equipment. Many of the State fish and game commissions will be able to furnish technical assistance and advice in planning for minnow production.

Fertilization of Minnow Pond

The production of minnows in ponds can be increased considerably by the use of fertilizers. Organic fertilizers such as barnyard manures, soybean meal, and cottonseed meal may be used. Ordinarily an inorganic fertilizer consisting of 8 parts nitrogen, 8 parts phosphoric acid, and 4 parts potash is suitable. Any other commercial farm fertilizer containing nitrogen and phosphoric acid is acceptable, but larger quantities may be necessary. A thousand or more pounds per acre of well-rotted barnyard manure may be applied at one application early in the season or at intervals during the summer. Excellent results have been obtained in rearing ponds with 400 pounds of cottonseed or soybean meal per acre. With inorganic fertilizers better results will be obtained if applications are made about every 10 days. As vegetation is used by most species as a place to deposit eggs, it should not be exterminated by the addition of too much fertilizer. At the beginning of the season approximately 100 pounds per acre should be used at each application. After turbidity develops so that objects can be seen at not more than about 2 feet in depth, applications should be made only in sufficient quantity to maintain this amount of turbidity. After the spawning season is over, the turbidity may be increased without affecting reproduction. If the pond becomes dense with submerged aquatic vegetation, more fertilizer should be added to increase the turbidity, which in turn will smother and help control the vegetation. The turbidity developed from the use of fertilizers is due to the tremendous numbers of microscopic plants and crustacea, which give the water a brown or green tinge sometimes called "water bloom."

The maintenance of microscopic algae and crustacea in such numbers throughout the summer growing season will provide the maximum in fish foods. Where it is desired to eliminate vegetation for seining or to facilitate collection of the fish, sodium arsenite may be used at the rate of 2½ parts per million parts of water as described in Fishery Leaflet 10, Use of Sodium Arsenite for Controlling Submerged Vegetation in Fish Ponds, Fish and Wildlife Service, Department of the Interior, Merchandise Mart, Chicago 54, Illinois.

GOLDFISH OR "BALTIMORE MINNOWS"

A brief account of goldfish propagation is given here because of the tremendous numbers used annually for baits. They are hardy and manage to live under adverse conditions during transportation.

Goldfish will reproduce in most ponds if aquatic vegetation is available for the deposition of their sticky eggs. At some goldfish hatcheries the brood fish are placed in spawning pens or boxes containing floating bunches of hornwort (Myriophyllum), fanwort (Cambomba), water hyacinth (Echornia) or other aquatic vegetation on which the eggs may be deposited. Some hatcherymen use willow roots tied to poultry wire covering about a third of the spawning compartment. When the vegetation has received a quantity of eggs, the brooders are removed from the pens or the vegetation is transferred to rearing ponds. The eggs hatch in 8 to 10 days if the water is between 60° and 70°F., or in 2 to 3 days if the water is between 80° and 90°F. Goldfish breeders are placed in the spawning compartments at the rate of two males to one female. In ponds where several breeders are placed the males should predominate but the ratio of males to females may be more nearly equal. The sexes can be separated at the start of the "driving period," a term used to designate the period when the males follow the females. At this time the males develop small growths that resemble grains of salt on their gill covers and the front part of their pectoral fins.

Goldfish may spawn from April to August, the period depending on temperatures, as they usually start spawning in the spring when the water reaches 55° to 60° F. A temperature of 60° to 70° F., is considered most desirable for common goldfish.

The young goldfish feed upon microscopic animals and plants. These organisms occur in all ponds but may be increased by the use of fertilizers, as explained elsewhere. Very young goldfish may be fed hard-boiled pulverized eggs. A satisfactory way of feeding is to wrap the eggs in a cloth and draw through the water. Cooked cereals are also excellent foods but must be fed in fine granules.

Before propagating or using goldfish as bait one should consult the laws regulating the waters involved, as some States prohibit their use. Goldfish, under certain conditions, may be detrimental to good fishing if they are allowed to escape. Trout fishing in many lakes has been ruined by goldfish introductions from surplus bait released in those waters. Goldfish have also "taken over" other bodies of water where fishermen have permitted their escape.

STONE CAT, MAD TOM, POISON CAT, TADPOLE CAT

These small catfishes belong to Schilbeodes and related genera. They may be distinguished from other catfishes by the low, continuous adipose fin, which is connected with the tail fin by a slight notch. These fish should be handled with care, as they have poison glands located just beneath the skin of the pectoral and dorsal spines. A wound from either of the spines is about as painful as a bee's sting.

These catfish usually range from 3 to 5 inches in length, but one eastern species may reach a length of 12 inches. Very tenacious of life, these fish serve as excellent bait for black bass and other game-fishes. These small cat-

fishes live under stones in riffles, and on dark moonless nights they may be collected by the use of short minnow seines and baits on the riffles. A very common method of taking these fish is to place on a fishhook a large number of earthworms in a ball about the size of a walnut. Others string the worms on a cotton thread with a needle until they have accumulated a ball of worms. This bait is fished in the riffles in the late evening and at night. The catfishes hold on to the bait and may be lifted out carefully and placed in a minnow pail.

These fish are so tenacious of life that only a limited number are needed for a fishing trip.

MICE

Mice are considered one of the finer baits for bass and pickerel. Field mice can be collected during spring and summer under bark, debris, and soil at the base of rotten stumps, under logs and boards, and under bundles of grain or shocks of wheat, oats, barley, and other grains. During the fall field mice can be found in abundance in their diggings at the bases of fodder-shocks.

Mice can be kept several days in small wooden or metal boxes or wire cages. Their boxes should be kept clean and supplied with fresh water at all times. They may be fed cracked or ground grain and small amounts of fresh fruit or vegetables.

Mice are prolific and can be propagated with ease. They reach sexual maturity at 2 to 3 months, and their gestation period is 21 days. Females produce litters of about five young every 30 days until they are about 18 months old.

Commercial breeders permit each male to have in his cage three to five females if they are without young. Each female is removed to a separate cage before the young are born and is kept there until the young are weaned. Usually the females are not bred again until they have ceased nursing the previous litter. The young are weaned when they reach an age of 20 to 25 days. By this system each mature female should produce successive litters at intervals of 6 or 7 weeks and in the course of a year should produce about 40 young. Mice may reach a size suitable for bait when they are 3 weeks old.

Wooden, metal, or wire cages may be used. Usually better results are obtained with large colonies if wooden boxes are used. The cages should be about 16 inches long, 14 inches wide, and 10 inches high. The front, back, and bottom should be made of galvanized-wire netting of 1/4-inch-square mesh. The bottom should be so constructed that a pan can be placed underneath to catch the droppings. Excelsior is ordinarily used for nesting material, and clean straw or shavings for bedding.

Mice do well on ground cereals, chicken laying mash, and supplements of small quantities of green feeds, boiled carrots, potatoes, or parsnips. Fresh water should be supplied at all times. Mice thrive best at temperatures of about 65°F.

Any of the several books written on the propagation of the white rat or guinea pig is applicable to the raising of mice.

A list of dealers in guinea pigs, white mice, and white rats, may be obtained from the Department of Agriculture, Washington 25, D. C.

PRESERVATION AND PREPARATION OF BAITS

Fishermen often find it beneficial, entertaining, and cheaper to prepare their own baits. When particular types of bait are plentiful, they can be preserved--often with little trouble--for use in times of scarcity.

MINNOWS

Quantities of minnows can be obtained by seining pools in small streams and in coves and shore areas of ponds and lakes. These minnows should be placed at once in the collecting pail, which contains the killing solution made with 1 part of formalin to 12 parts water. The minnows are then transferred from the killing solution to a jar that contains 1 per cent formalin and 99 per cent water and can be sealed air-tight. The bait should be observed about every 2 days. If the water becomes discolored, the minnows should be washed and placed in a new solution. If the minnows become too stiff, less formalin should be used; if too soft, more formalin should be added. After perhaps two or three changes the fluid will remain clear and preserve the minnows indefinitely. The addition of 5 to 10 per cent glycerine will help to maintain softness and reduce the breaking of fins.

If the formalin odor is objectionable, the fish can be preserved in 1 part formalin, 6 parts glycerine, and 40 parts water. After a month or 6 weeks the minnows may be removed and placed in a strong brine, which will remove formalin odor and preserve the minnows in a useable form.

If it is desired to keep minnows only a few days or weeks and formalin is unobtainable, the minnows can be preserved by placing them in layers--each layer covered with salt--in a wooden, earthen, or glass vessel. Or the minnows can be placed in layers on a piece of cloth, covered with salt, rolled up, and tied. Salt will shrivel the minnows, but they will regain their former shape when placed in water.

If minnows are not too crowded in an air-tight jar, they can be preserved indefinitely in a solution of 5 per cent formalin. If kept in a dark place, they will retain their color and silvery hue better than if stored in the light.

Before the minnows are used, they should be soaked in cold water to remove the formalin. After the minnows have been soaked, a few drops of oil of rhodium may be put on them to reduce or disguise the formalin odor.

CUT BAITS

Fresh meats are used principally as bait for catfishes. Fishermen also use gar-fish, mud-fish, suckers, and other nongame fish as cut-bait. The poorer grades of beef and pork are sometimes used. The meat of rodents or of almost any animal (as long as it is fresh) makes excellent bait for trout-line use. It is usually cut into chunks about 1 inch square or larger. The intestines or viscera of fowl and small mammals also make good bait.

Fish and other types of meat retain their juices and keep better if they are not cut into baits until just before they are to be used.

CARP BAIT

Nearly every carp fisherman has his own method of making dough balls. The important thing is to have dough that is firm and holds together well while it is being fished.

The following recipe has given very satisfactory results: 1/2 cup of plain flour, 1/2 cup of plain corn meal, a little salt, enough water to form a smooth working dough. Sometimes cotton is worked into the dough to give it strength and consistency. The dough is dropped into boiling water for 20 minutes. When cool, the dough may be worked into any shape desired. Oil paper may be placed in the bottom of the kettle to keep the dough from sticking.

Some fishermen add grated cheese before boiling. Others prefer to add ground meat. It is said that in some regions good results have been obtained by adding cottonseed meal.

Another recipe calls for: 2 large potatoes peeled and grated, 1/2 teaspoonful of salt, 1 tablespoonful of corn meal, and enough wheat flour and cotton to give a stiff batter. Balls about 1 inch in diameter are rolled, dropped into boiling water, and cooked until they float.

"STINK" BAIT

Stink bait is used extensively in some parts of the country for catching channel and flathead catfish. Almost everyone who does very much of this type of fishing has his own formula for making the bait. The most common procedure, however, is to take a quantity (usually the content of a 5-gallon oil can) of minnows or small gizzard shad and allow them to decompose until there is nothing but a thick oily substance in the can. Other ingredients such as sliced bananas and oil of anise are added. Ordinarily a piece of sponge is dipped into this liquid and then placed on the hook for bait. Another method of preparation is to make a stiff dough, saturate it with the stinking solution just described, and mold it around the shank of a treble hook.

SALMON EGGS

All the commercial packers of bait eggs have processes which they believe give their eggs superior quality. These processes are trade secrets. The general information given here may need some modification to obtain the precise color and quality desired.

Salmon eggs to be prepared for bait should be fresh, have a firm consistency, and separate easily from the egg membranes. They should be large and have the pale reddish color of mature eggs.

The first step is to split the egg sac open and pour hot water over the roe to separate the eggs from the attached membrane. Some eggs will not become detached: these can be rubbed lightly over a wire mesh screen, as too long exposure to hot water may damage the membranes of the eggs and make them

unfit for use. The eggs should fall on an inclined screen with fine wire mesh, this screen leading to a large shallow box. The eggs drain on the screen and finally slide into the box.

One method of preparation requires that the separated eggs be placed in a solution of salt, sugar, and coloring material. The proportion of salt varies with the different packers and may range from 1 part sugar in 3 parts salt to as much as 9 parts of salt. The brine solution should test 80 to 90 per cent by salinometer. The coloring material used consists of various shades of aniline dyes such as safrennin or Sherwin-Williams 3-R. Naturally, the intensity of the color will depend upon the strength of the dye and the length of time the eggs are exposed to the dye. Eggs should be stirred through the brine and coloring matter with a wooden paddle to insure equal absorption. The time required in the brine varies with the season, temperature, and so on, but apparently the eggs should be left in it at least 20 or 30 minutes. The cured eggs must have a firm, jelly-like consistency, so that they will not be stripped easily from the hook; the eggs must not be too hard, neither shrunken, brittle, nor rubbery. When the eggs have been sufficiently colored and cured, they should be drained and packed in air-tight containers. These eggs will keep indefinitely if unopened and kept in a cool dry place. If the eggs are used in warm regions, it will be desirable to add a solution of 1 per cent sodium benzoate or 5 per cent formalin.

By another method of preparation the eggs of freshly caught fish are immersed in salt solution. In order that the salt solution may not be too strong, salt should be added slowly until the eggs just barely float; the eggs will collapse in too strong a solution. The eggs should remain in this solution only until the slime is cut, when they should be drained of all superfluous moisture, even dried with cheesecloth if necessary. Eggs may then be put in glycerine of good quality and kept in a tight jar, where they will keep for a considerable time in a cool place. Before using, small quantities are usually drained of glycerine and placed in small tin cans that are tightly covered. Eggs once removed from the glycerine cannot be replaced in it.

"Cluster eggs" are also marketed as bait for steelhead trout. Clusters of immature or "green" roes are washed and cured as described for the single eggs.

PORK RIND

Free the pork skin from the fat and cut into strips of the desired size. Place the strips in a solution of brine strong enough to float a potato. See that all pieces are submerged. After soaking for 48 hours or longer, the pork rind can be removed and bleached by soaking in dilute hydrochloric or acetic acid until it becomes white. Pack in air-tight jars and cover with 5 parts glycerine to 95 parts of a 10 per cent formalin solution. A 1 per cent solution of sodium benzoate in water may be used in place of the formalin.

WATER-PROOFING DRY FLIES

Cut 4 ounces of paraffin into very thin slices and dissolve in 1/2 pint of white gasoline or dry-cleaning fluid (carbon tetrachloride). It will take several hours for the paraffin to dissolve, but the solution can be used as

soon as the paraffin is in solution. Flies dipped in this solution should be dried immediately, as the solution is destructive of cements and varnishes left too long in it. The solution should not be permitted to come in contact with rubber or celluloid equipment, as it will dissolve them. The bodies of flies with artificial wings should be painted with a brush, as the solution may destroy the plastic veination. On cold mornings the paraffin may solidify: but if placed in a shirt pocket under a warm jacket, it will usually absorb enough heat to dissolve again. The solution is inflammable and should be kept away from an open fire.

TREATMENT FOR SPANISH GUT LEADER

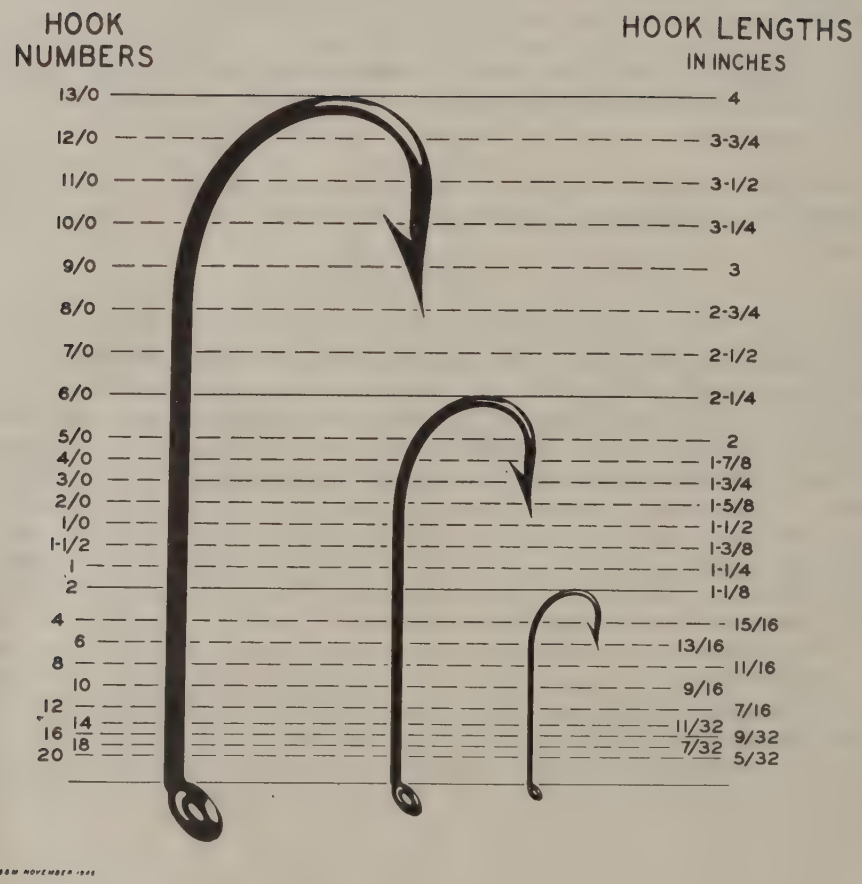
One of the best methods of giving old Spanish gut new life and pliability is to soak the leaders in a solution made by mixing 1 ounce of glycerine and 4 ounces of water. The strength of gut leaders deteriorates if they are left in water overnight or for several hours at a time.

The favorite mist color can be obtained by soaking gut leaders in blue or gray aniline dye dissolved in warm water. Do not boil, as this weakens the leader.

The sheen of Spanish gut can be removed by applying with a cloth a very light coat of a mixture of pumice and glycerine.

FISH HOOKS

Hooks were made in several countries before the war, but the majority of the fly hooks sold in this country came from Norway and England. There is no standard terminology by which all hooks can be described to indicate length of shank, width of bend, length of barb, and type of point. Although the same numbering system may be used, nearly all the foreign manufacturers have variations in their lengths of shank, shape and quality of hook. There have been many attempts to standardize the length of shank, width of bend, diameter of wire, and other features, but there have been few concrete results. During the last few years, however, there has been some success in getting established in this country a standard for fly hooks. This standard was proposed by the National Association of Angling and Casting Clubs. The Association proposed that fly-hook size be governed by length of shank, exclusive of eye; that the gap between the point and shank be one-half the length of the straight shank; that the diameter of the eye be the same as the diameter of the wire; and that the standards be applicable to every bend and style of hook. The chart is drawn to scale to show the relation of size numbers to length of shank:


HOOK NUMBERS
HOOK LENGTHS IN INCHES
13/0
12/0
11/0
10/0
9/0
8/0
7/0
6/0
5/0
4/0
3/0
2/0
1/0
1-1/2
1
2
4
6
8
10
12
14
16
18
20
4
3-3/4
3-1/2
3-1/4
3
2-3/4
2-1/2
2-1/4
2
1-7/8
1-3/4
1-5/8
1-1/2
1-3/8
1-1/4
1-1/8
15/16
13/16
11/16
9/16
7/16
11/32
9/32
7/32
5/32

Sizes of fly hooks ordinarily used for fresh-water species are as follows:

Trouts - 10, 12, 14; steelhead trout - 4, 6; salmon - 2, 4; panfish - 4, 6; black basses, pickerel, walleyed pike - 1, 1/0. Slightly smaller or larger hooks should be used according to water conditions and the size of the fish.

Sizes of bait hooks ordinarily used for fresh and salt-water fishes are as follows:

Trouts - 10, 8, 6; black basses, pickerel, walleyed pike - 2/0 to 6/0; weakfish, bonefish - 4/0; croaker, kingfish, sea bass, porgy, lung, blackfish, and pollack - 1/0 to 3/0; flounder - 1/0; channel or striped bass - 7/0; tarpon - 7/0 to 10/0; tuna - 7/0 to 13/0; halibut - 3/0 to 10/0; sailfish, marlin, broadbill - 10/0 to 13/0

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